

Real Options

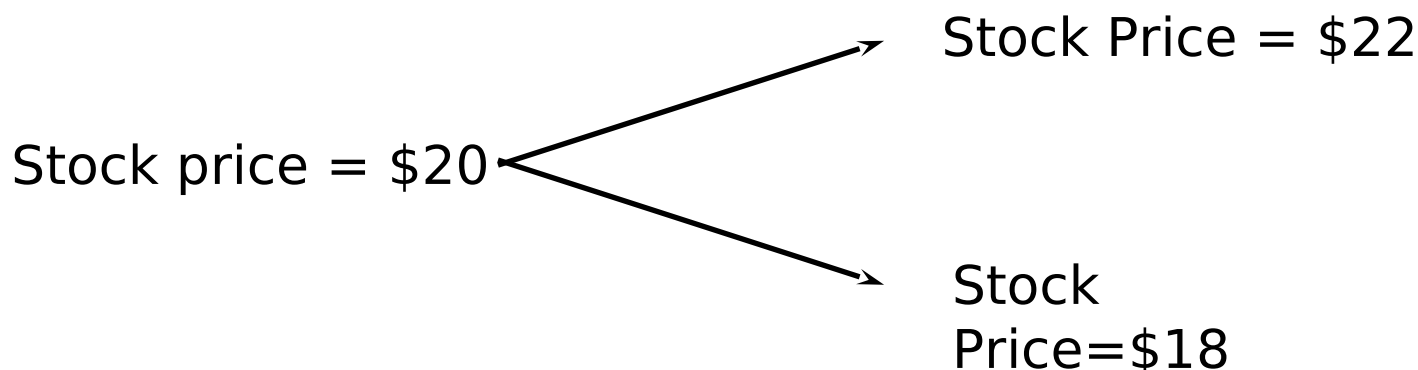
Chapter 33

An Alternative to the NPV Rule for Capital Investments

- Define stochastic processes for the key underlying variables and use risk-neutral valuation
- This approach (known as the real options approach) is likely to do a better job at valuing growth options, abandonment options, etc than NPV

The Problem with using NPV to Value Options

- Consider the example from Chapter 11: risk-free rate = 12%; strike price = \$21



- Suppose that the expected return required by investors in the real world on the stock is 16%. What discount rate should we use to value an option with strike price \$21?

Correct Discount Rates are Counter-Intuitive

- Correct discount rate for a call option is 42.6%
- Correct discount rate for a put option is -52.5%

General Approach to Valuation

- We can value any asset dependent on a variable θ by
 - Reducing the expected growth rate of θ by λs where λ is the market price of θ -risk and s is the volatility of θ
 - Assuming that all investors are risk-neutral

Extension to Many Underlying Variables

- When there are several underlying variables θ_i we reduce the growth rate of each one by its market price of risk times its volatility and then behave as though the world is risk-neutral
- Note that the variables do not have to be prices of traded securities

Estimating the Market Price of Risk Using CAPM (equation 33.2, page 748)

The market price of risk of a variable is given by

$$\lambda = \frac{\rho}{\sigma_m} (\mu_m - r)$$

where ρ is the instantaneous correlation between percentage changes in the variable and returns on the market, σ_m is the volatility of the market's return, μ_m is the expected return on the market and r is the short-term risk-free rate

Example of Application of Real Options Approach to Valuing Amazon.com (Business Snapshot 33.1; Schwartz and Moon)

- Estimate stochastic processes for the company's sales revenue and its average growth rate.
- Estimated the market price of risk and other key parameters (cost of goods sold as a percent of sales, variable expenses as a percent of sales, fixed expenses, etc.)
- Use Monte Carlo simulation to generate different scenarios in a risk-neutral world.
- The stock price is the average of the present values of the net cash flows discounted at the risk-free rate.

Commodity Prices

- Futures prices can be used to define the process followed by a commodity price in a risk-neutral world.
- We can build in mean reversion and use a process for constructing trinomial trees that is analogous to that used for interest rates in Chapter 30

Example (page 754)

- A company has to decide whether to invest \$15 million to obtain 6 million units of a commodity at the rate of 2 million units per year for three years.
- The fixed operating costs are \$6 million per year and the variable costs are \$17 per unit.
- The spot price of the commodity is \$20 per unit and 1, 2, and 3-year futures prices are \$22, \$23, and \$24, respectively.
- The risk-free rate is 10% per annum for all maturities.

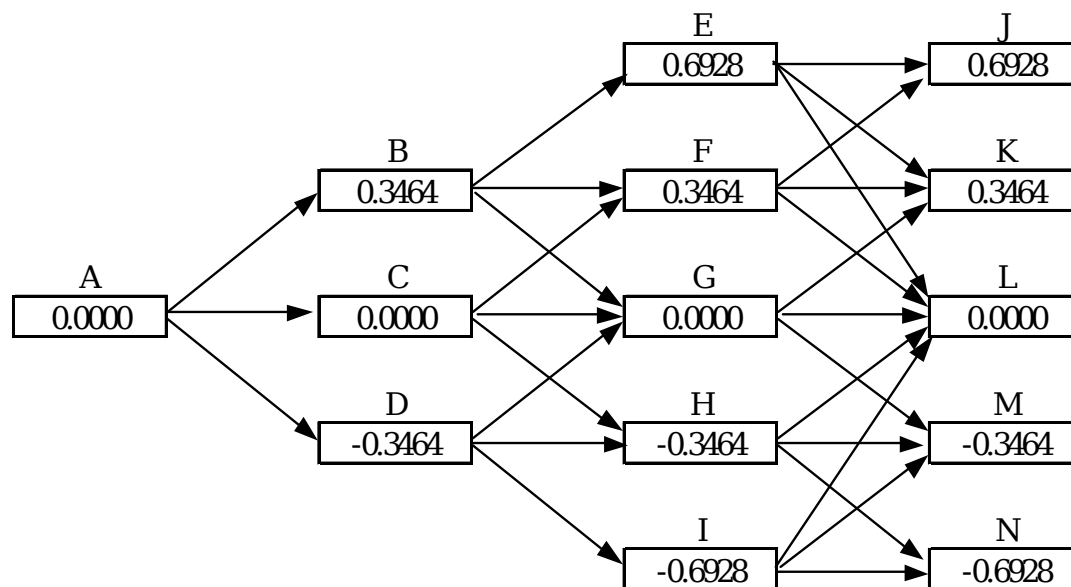
The Process for the Commodity Price

We assume that this is

$$d \ln(S) = [\theta(t) - a \ln(S)] dt + \sigma dz$$

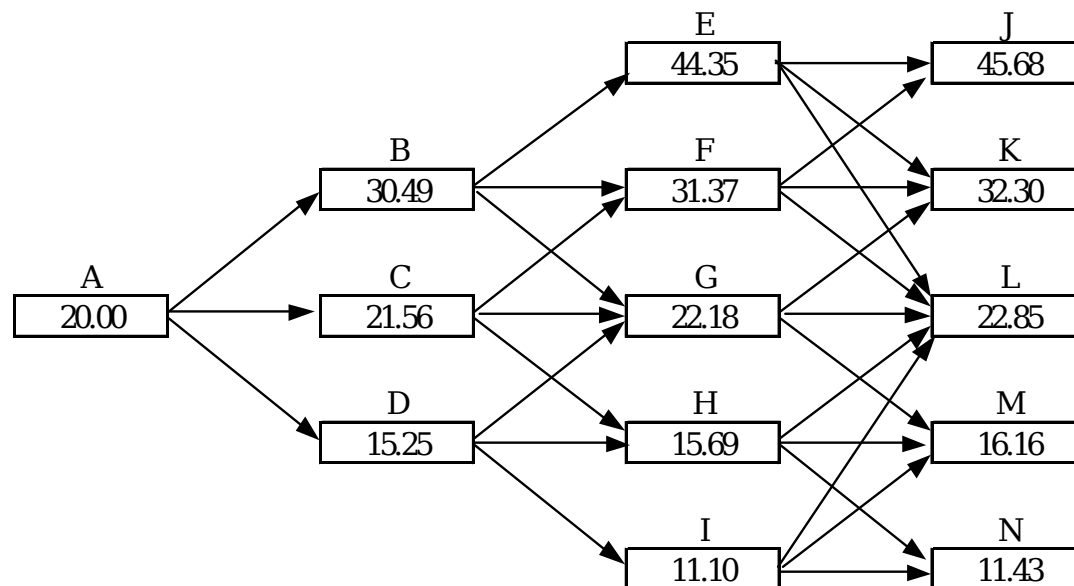
where $a = 0.1$ and $\sigma = 0.2$

Tree Assuming $\theta(t)=0$; Fig 33.1



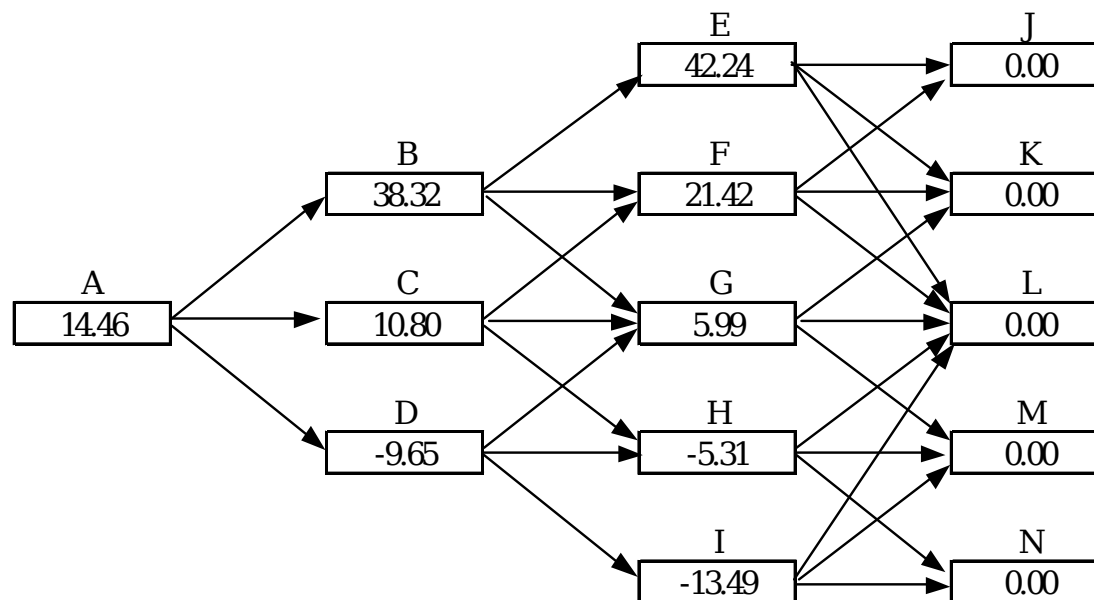
Node	A	B	C	D	E	F	G	H	I
p_u	0.1667	0.121 7	0.166 7	0.221 7	0.886 7	0.121 7	0.166 7	0.221 7	0.086 7
p_m	0.6666	0.656 6	0.666 6	0.656 6	0.026 6	0.656 6	0.666 6	0.656 6	0.026 6
p_d	0.1667	0.221 7	0.166 7	0.121 7	0.086 7	0.221 7	0.166 7	0.121 7	0.886 7

Final Tree; Fig 33.2



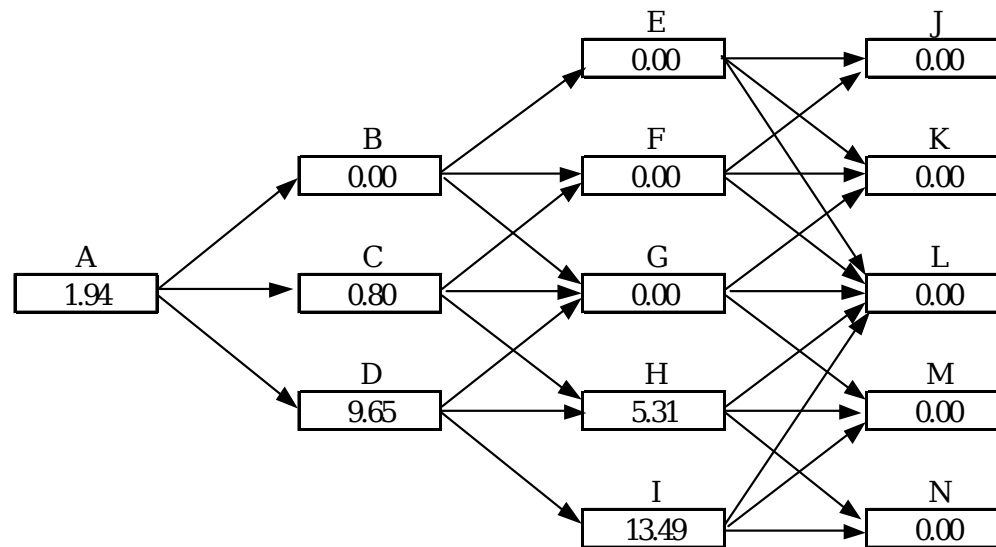
Node	A	B	C	D	E	F	G	H	I
p_u	0.1667	0.121 7	0.166 7	0.221 7	0.886 7	0.121 7	0.166 7	0.221 7	0.086 7
p_m	0.6666	0.656 6	0.666 6	0.656 6	0.026 6	0.656 6	0.666 6	0.656 6	0.026 6
p_d	0.1667	0.221 7	0.166 7	0.121 7	0.086 7	0.221 7	0.166 7	0.121 7	0.886 7

Valuation of Base Project; Fig 33.3



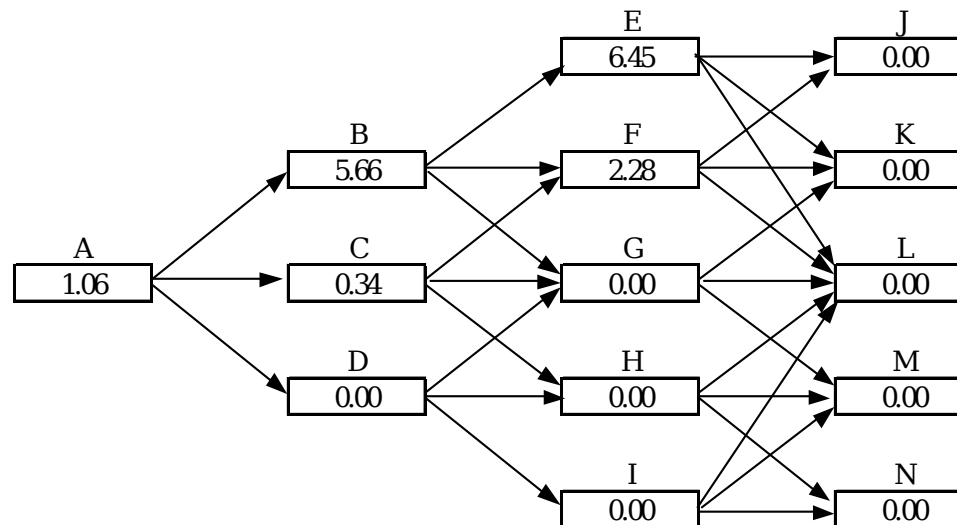
Node	A	B	C	D	E	F	G	H	I
p_u	0.1667	0.121 7	0.166 7	0.221 7	0.886 7	0.121 7	0.166 7	0.221 7	0.086 7
p_m	0.6666	0.656 6	0.666 6	0.656 6	0.026 6	0.656 6	0.666 6	0.656 6	0.026 6
p_d	0.1667	0.221 7	0.166 7	0.121 7	0.086 7	0.221 7	0.166 7	0.121 7	0.886 7

Valuation of Option to Abandon; Fig 33.4 (No Salvage Value; No Further Payments)



Node	A	B	C	D	E	F	G	H	I
p_u	0.1667	0.121 7	0.166 7	0.221 7	0.886 7	0.121 7	0.166 7	0.221 7	0.086 7
p_m	0.6666	0.656 6	0.666 6	0.656 6	0.026 6	0.656 6	0.666 6	0.656 6	0.026 6
p_d	0.1667	0.221 7	0.166 7	0.121 7	0.086 7	0.221 7	0.166 7	0.121 7	0.886 7

Value of Expansion Option; Fig 33.5 (Company Can Increase Scale of Project by 20% for \$2 million)



Node	A	B	C	D	E	F	G	H	I
p_u	0.1667	0.1217	0.166 7	0.221 7	0.886 7	0.121 7	0.166 7	0.221 7	0.086 7
p_m	0.6666	0.6566	0.666 6	0.656 6	0.026 6	0.656 6	0.666 6	0.656 6	0.026 6
p_d	0.1667	0.2217	0.166 7	0.121 7	0.086 7	0.221 7	0.166 7	0.121 7	0.886 7